Older Vehicles and Air Pollution: Insights from the 1995 NPTS

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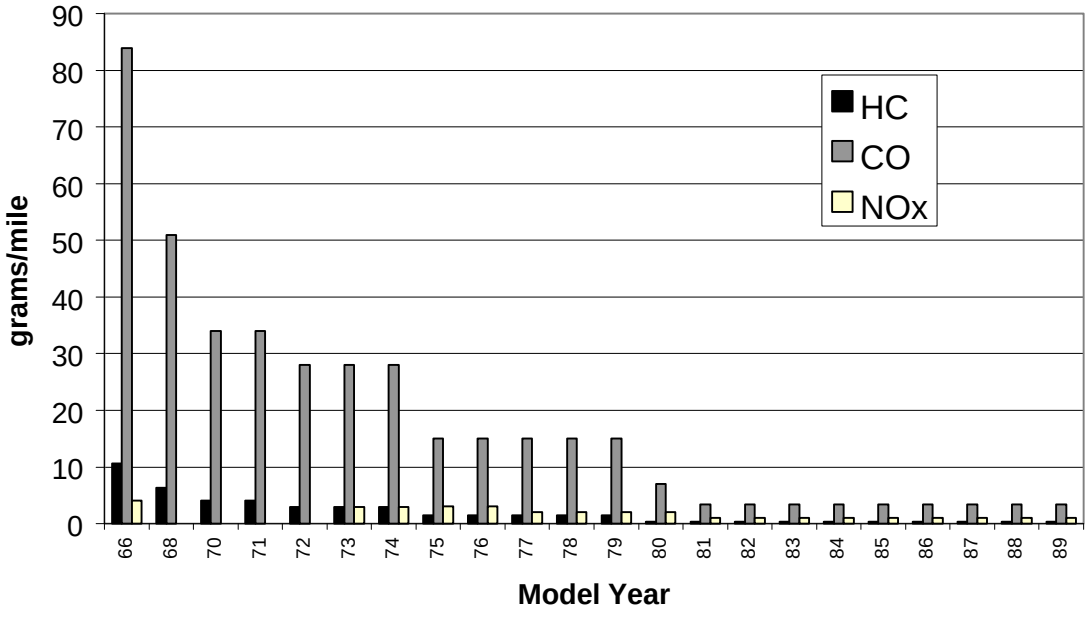
Introduction

Older Vehicles and Air Quality

Levels of air pollutant emissions and vehicle age are tied together for two reasons. First, starting in 1968, federal standards reduced air pollutant emissions from new automobiles (Figure 1). Newer vehicles include more and better pollution control devices, such as catalytic converters. Secondly, pollution control equipment deteriorates over time. For example, the model used by the U.S. Environmental Protection Agency (EPA) to quantify mobile source emissions (MOBILE) estimates that carbon monoxide (CO) emissions are ten times higher after four years or 50,000 miles, volatile organic compounds (VOCs) are about four times higher, and nitrogen oxide (NOx) emissions are about twice as high as when the car was new (National Cooperative Highway Research Program 1997).

Because emissions are higher for older vehicles, they contribute disproportionately to overall emissions from motor vehicles. For example, in 1990 the EPA estimated that cars built before 1972 comprised about 3.4% of the total auto fleet and only 1.7% of the vehicle miles traveled (VMT), but produced 7.5% of the hydrocarbon[1] (HC), 7.6% of the CO, and 4.7% of the NOx emissions of the fleet. The California Air Resources Board (CARB) estimated that pre-1972 cars were 4% of all California vehicles in 1990, yet produced 13% of the HC and 9% of the CO emissions (U.S. Congress 1992).

Figure 1: Federal Automobile Tailpipe Emission Standards



Source: (U.S. Congress 1992)

[1] Hydrocarbons (HC) and volatile organic compounds (VOCs) are both groups of chemical compounds containing carbon that contribute to the formation of ozone, also known as smog.

Aging of the Vehicle Fleet

Because older vehicles pollute more and new vehicle standards are periodically strengthened, fleet turnover is important in reducing overall vehicle emissions. However, over the past 20 years, vehicle turnover has slowed as the personal vehicle fleet has aged (Table 1).

Table 1: Average Household Vehicle Age

	*1969**	*1977*	*1983*	*1990*	*1995*	*% change, 1977-1995*
Passenger Car	5.1	5.5	7.2	7.66	8.23	50%
Truck/Van		6.4	8.8	7.95	8.22	30%
Total Fleet		5.6	7.6	7.70	8.32	49%

* The 1969 NPTS did not include pickup and other light trucks as household vehicles.

Sources: (Hu 1992; Pickrell 1998)

Policy Responses

In the early 1990s, the increasing age of the fleet and higher emission from older vehicles grabbed the attention of private industry, regulators, and elected officials faced with new mandates from the 1990 Clean Air Act Amendments. In 1990, the Unocal oil company launched the South Coast Recycled Auto Project (SCRAP) by offering residents of the Los Angeles region $700 for their pre-1971 cars. Nearly 8,400 cars were scrapped through this program (Unocal Corporation no date). Unocal's objective was to demonstrate that scrapping older vehicles reduced emissions in a more cost-effective manner than stringent new standards on stationary sources of air pollution, including oil refineries. The program attracted national attention to the problem of older vehicles and the potential use of "mobile source emission reduction credits" (MERCs) to comply with air quality regulations. A system for banking and trading emission credits generated by stationary sources of pollution, such as factories and refineries, was already in place in the South Coast Air Basin and many other regions. Credits are generated when emissions are reduced from one source below what is required under regulations. The credits can then be bought or traded to permit a new source of pollution in the basin or delay compliance with a regulation. Often, the credits are discounted to help ensure a net decrease in emissions.

Since Unocal's initial SCRAP program, several companies and public agencies throughout the country have implemented similar programs, also known as vehicle buy back, cash-for-clunkers, or voluntary accelerated vehicle retirement (VAVR). In some cases vehicles are scrapped to generate emission credits. Some agencies use public funds to purchase vehicles without generating credits, thereby reducing the region's overall emissions. To help ensure that real pollution reductions occur, VAVR programs impose several conditions. For example, in most areas the vehicle must be in operating condition and be registered in the region for a certain length of time (to prevent the importation of old vehicles).

The effectiveness of such programs in reducing air pollution hinges upon the answers to several questions (Hsu 1994):

- How much earlier was the vehicle retired?
- How would the vehicle be driven if not retired?

- What are the emissions levels of the retired vehicles?
- How was the VMT replaced?
- What is the VMT for the replacement vehicle, if there is one?
- What are the emissions of the replacement vehicle?

Both the EPA and CARB have issued guidance or regulations regarding VAVR programs that attempt to address some of these questions. For example, both agencies recommend a three year remaining life for retired vehicles. CARB also recommends using fleet averages by model year for the retired vehicle's VMT and emissions rates and overall light duty fleet emission rates for the replacement vehicle (California Air Resources Board 1998; Environmental Protection Agency Office of Mobile Sources 1993).

In addition to questions surrounding how to calculate emission reduction benefits, critics of VAVR programs are concerned about impacts on low-income households. By accelerating the scrappage of older vehicles, these programs could reduce the supply of cheap cars and trucks. If the vehicles are scrapped without stripping parts (as recommended by CARB), this could also reduce the supply and increase the price of used parts. The magnitude of these potential impacts is largely unknown, and policymakers emphasize that the programs are voluntary. However, critics (particularly car collectors) fear programs will increase in scale or become less than voluntary. In addition, environmental justice advocates have criticized the programs because of how and where the MERCs are used. They charge that low-income and minority communities, where many of the stationary sources of pollution are located, may be exposed to higher levels of pollution because companies delay compliance with regulations by purchasing MERCs generated from scrapped vehicles.[2]

Research Objectives

Data from the 1995 Nationwide Personal Transportation Survey (NPTS) may help answer some of these questions. In particular, this paper attempts to describe the households that own older vehicles and how they use them. Vehicles built before 1981, when tailpipe standards were made particularly more stringent, are of particular concern. Describing who owns older vehicles helps answer two related questions:

1. **Who are the potential participants in VAVR programs?** VAVR programs, as currently designed, may only attract a segment of older vehicle owners. Alternative programs, such as repair programs, might attract other segments. In addition, household characteristics help determine how old vehicles are replaced.

2. **Who might be impacted by VAVR programs?** If VAVR programs or other policy responses reduce the supply of inexpensive older vehicles or used part, who might be impacted? Mandatory programs and disincentive policies, such as increased registration fees

[2] This issue is not addressed further in this paper in that is deals with the use MERCs generated from VAVR programs and not the programs directly.

for older vehicles, though not under serious consideration now, could increase impacts on some households.

Describing how older vehicles are driven also provides insight to the impacts of programs on various households. Vehicle use data could also be used to answer two additional questions:

1. **How much do older vehicles contribute to air pollutant emissions?** Current estimates are generally based on overall VMT. However, the number and length of trips, the time between trips, and the time of day of the trip can influence emissions and pollution levels. If these factors differ between older and newer vehicles, current emissions estimates may be too high or too low.

2. **How effective are VAVR programs?** One of the key questions in assessing the impact of VAVR programs (or other policy options) is how would the vehicle be driven if it was not retired. If we assume that current driving patterns for a particular household vehicle are a fairly accurate indicator of driving patterns in the near future (e.g. the next three years), travel survey data can help answer this question.

This paper serves as a starting point to answer these questions using the 1995 NPTS dataset.

Description of the Older Vehicles

Overall, 11.7% of the vehicles in the NPTS survey with known model years were made before 1981. Over half (56.7%) are automobiles and 28.2% are pickup trucks. Another 5.0% are vans and 4.1% are sport utility vehicles (SUVs). The distribution of vehicle types differs from newer vehicles. The pre-1981 vehicles are more likely to be pickup trucks (16.4% of the 1981 and newer vehicles) and less likely to be automobiles (66.0% of newer vehicles). Vans, SUVs, and pickup trucks make up 37.2% of the pre-1981 vehicles and 32.1% of the newer vehicles. The older vehicles are also more likely to be other trucks, recreational vehicles, motorcycles, and "other private vehicles," though these classes represent only 4.9% of all pre-1981 vehicles and 1.5% of the newer vehicles. Because new vehicle tailpipe standards for light trucks, vans, and SUVs came later than for automobiles, the higher proportion of these vehicles in the pre-1981 fleet is of concern.

Who Owns Older Vehicles?

Regional Differences

Older vehicles are more prevalent in warmer climates, particularly in areas that do not salt roads for de-icing, which reduces vehicle life. Table 2 shows that nearly 19% of the household vehicles in the West were made before 1981. These vehicles make up less than 6% of the household fleet in the Northeast.

Table 2: Vehicle Model Year by Region

Census Region	*pre-1970*	*1970-80*	*1981 & newer*
Northeast	0.7%	5.2%	94.1%
North Central	1.6	9.0	89.4
South	1.6	9.1	89.3
West	4.0	14.7	81.3
Nationwide	2.0	9.7	88.3

Income

Lower income households are more likely to own older vehicles. However, the ownership pattern of pre-1970 vehicles differs from model years 1970-80 ("1970s vehicles"). Figure 2 shows that about 10% of the 1970s vehicles are owned[3] by households with annual incomes less than $10,000. Another 16% are owned by households with incomes of $10,000-19,999. However, only 4% and 9%, respectively, of the pre-1970 vehicles are owned by these households. This pattern is similar to the 1981 and newer vehicles. This indicates that the pre-1970 vehicles are more likely to be classic or collector vehicles of high monetary value.

Using the household as the unit of analysis provides additional insight. Figure 3 shows that 30% of the households with incomes under $10,000 that have a vehicle have a pre-1981 vehicle. The rate of pre-1981 vehicle ownership falls as income rises. Overall, 18% of all households with vehicles that reported their income own a pre-1981 vehicle.

[3] The NPTS does not ask whether household vehicles are owned or leased. For the purposes of this paper, a broad definition of the term "owned" will be used, which includes vehicles owned, leased, or otherwise in the possession of the household.

Figure 2: Distribution of Vehicles by Household Income

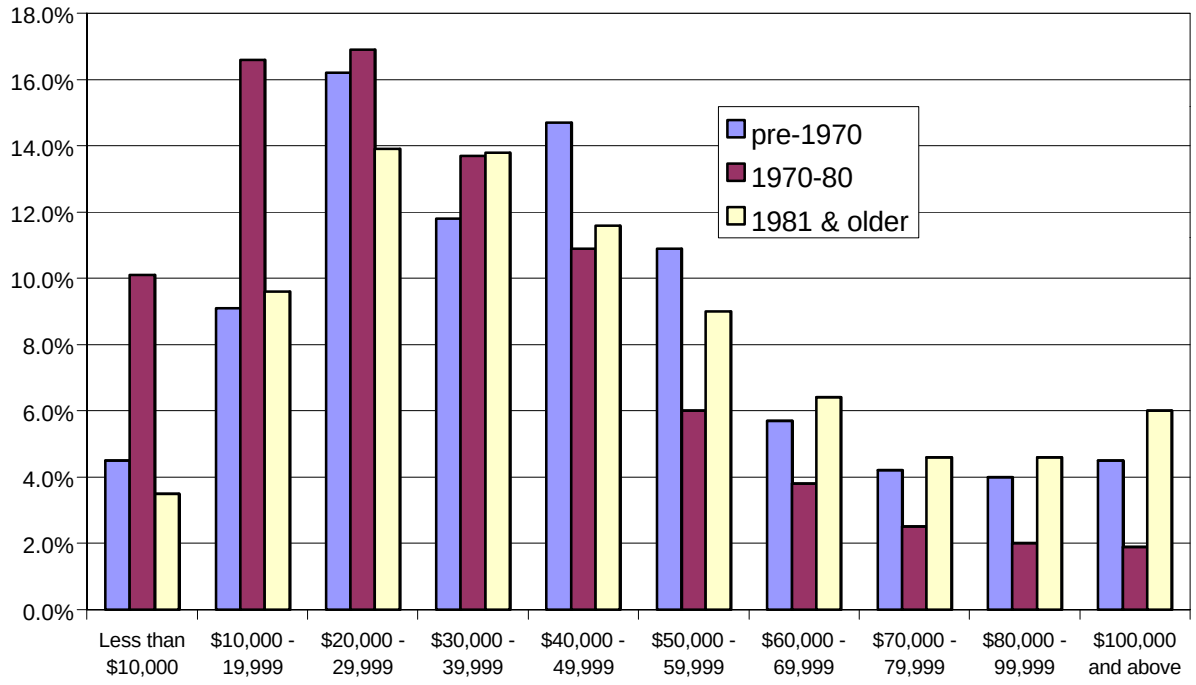
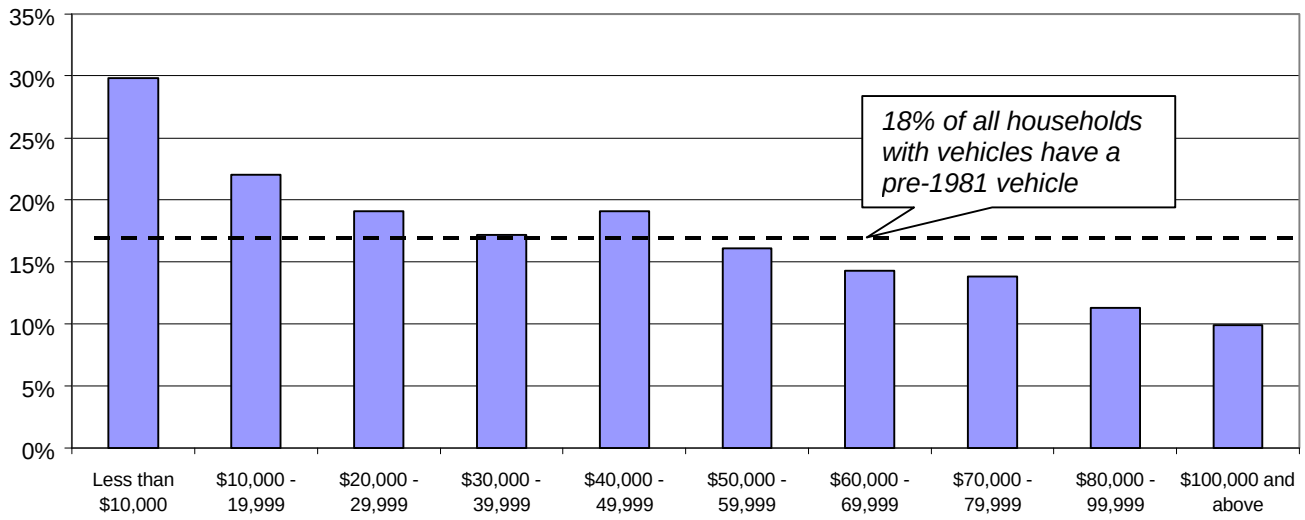


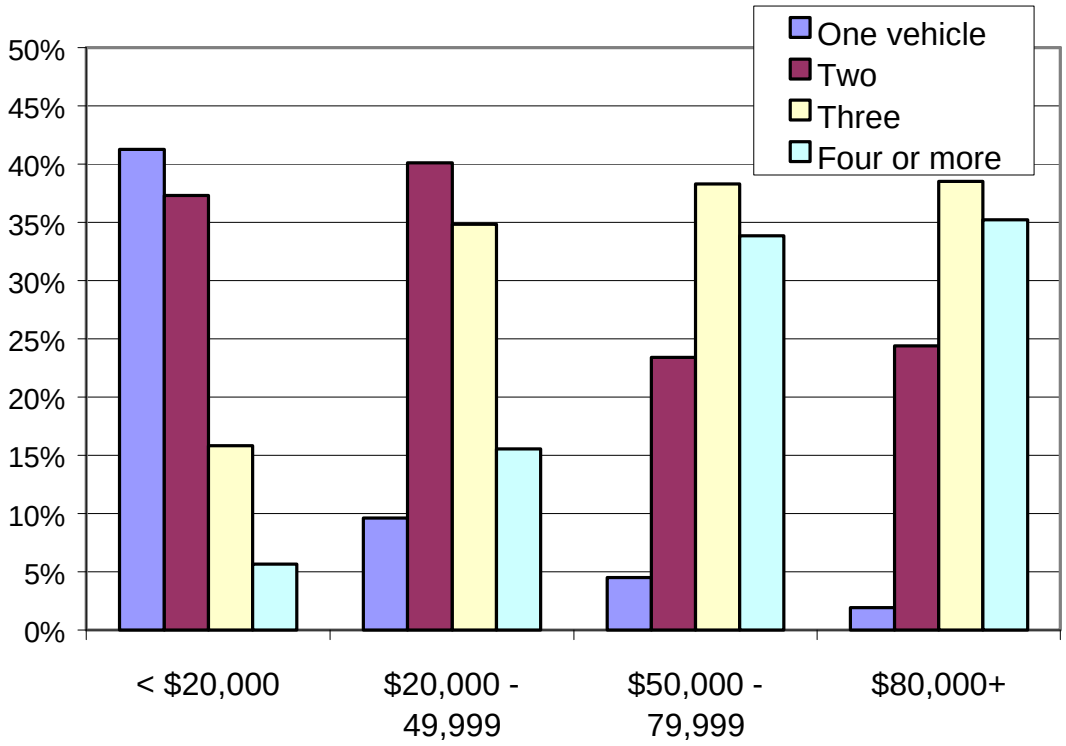
Figure 3: Percent of Households (with vehicles) with a pre-1981 Vehicle by Income



For lower income households, a pre-1981 vehicle is more likely to be their only vehicle. Figure 4 includes households that own a pre-1981 vehicle and shows the percent of households for each income group with one, two, three, or four or more household vehicles. Over 40% of the lowest income households with pre-1981 vehicles, own only one vehicle – the pre-1981 vehicle. These

households represent 10.5% of all households with pre-1981 vehicles. In contrast, households with higher incomes and at least one pre-1981vehicle own more vehicles.

Figure 4: Number of Household Vehicles-
Households with pre-1981 Vehicles, by Income



Overall, 14.5% of the pre-1981 vehicles are in single vehicle households and 8.5% are in single vehicle households with incomes under $20,000. About one-quarter (24.5%) of the vehicles are in households with incomes under $20,000. These households are financially the least likely to be able to replace an older vehicle with a newer vehicle. In particular, 17.5% of the pre-1981 vehicles are in households with one or two vehicles and incomes under $20,000. These vehicles would seem the least likely to end up in a VAVR program if the bounties offered are too low to purchase another vehicle.[4]

Lower income households are more likely to have acquired their 1970s vehicle used. Over half (52.8%) of all the household vehicles were acquired used, while 81.2% of the 1970s vehicles were acquired used. For 1970s vehicles in households with incomes under $10,000, 85.1% were obtained used. About one-fifth (20.4%) of all pre-1981 vehicles were acquired used by households with incomes under $20,000 and another 35.4% were acquired used by households with incomes of $20,000-49,999.

[4] Most VAVR programs in the U.S. offer $500 – 700 per vehicle. However, programs in some European countries offer rebates of over $1,000 (US equivalent) when vehicles are traded in for new vehicles. These programs are aimed, in part, to support domestic auto manufacturers.

Race

Though lower income households are more likely to be non-white or Hispanic, older vehicles are more likely to be in white households. This is due, in part, to the larger number of non-white households with no vehicles. Table 3 shows the distribution of vehicles among households, by vintage and race. For example, 85.3% of the 1970s vehicles are in white households, while white households are 80.4% of all households and 82.8% of households with vehicles.

Table 3: Percent of Vehicles in Households by Race

	% of Vehicles			*% of Households*	
Race of Household (by reference person)	***pre-1970***	***1970-80***	***1981 & newer***	***Households w/ vehicles***	***All Households***
White	89.3%	85.3%	84.5%	82.8%	80.4%
African-American	4.2	8.0	8.4	9.8	11.9
Asian	0.3	1.0	2.0	1.9	1.9
Other	6.1	5.7	5.1	5.5	3.8
Hispanic	7.1%	7.2%	6.9%	7.5%	7.8%
Non-Hispanic	92.9	92.8	93.1	92.5	92.2

Overall, only 15.2% of the African-American households with vehicles and 10.2% of the Asian households with vehicles own a pre-1981 vehicle, compared to 18.9% of white households with vehicles and 18.5% of all households with vehicles.[5] However, Hispanic households with vehicles are slightly more likely than non-Hispanic households with vehicles to have a pre-1981 vehicle, 19.5% versus 18.4%, respectively.

Urban vs. Rural

Households in non-urban areas (less than 1,000 persons per square mile) are more likely to have a pre-1981 vehicle than households in urban areas (22.5% versus 16.1% for households with vehicles). Overall, 45.6% of the pre-1981 vehicles are in non-urban households, compared to 40.2% of all vehicles. This reflects, in part, higher vehicle ownership rates for non-urban households. Urban households have an average of 1.64 vehicles, compared to 2.04 for non-urban households.

Household Composition

Of households that have vehicles, those with pre-1981 vehicles tend to be larger, have more drivers and adults, and have more vehicles, despite having lower incomes (Table 4). However, the number of workers per household is about the same as in households with only 1981 and newer vehicles.

[5] Household race is determined by the race of the "reference" person – the primary adult respondent to the survey.

Table 4: Household Characteristics – With and Without pre-1981 Vehicles

	Hhlds with pre-1981 vehicles	*Hhlds with only 1981 & newer vehicles*
Hhld size	2.81	2.58
# hhld drivers	1.98	1.82
# workers in hhld	1.39	1.35
# adults	2.06	1.89
# hhld vehicles	2.55	1.78
Mean Income[6]	$37,740	$46,590
Median Income	$27,500	$37,500

The large portion of retired households with older vehicles contributes to the lack of a large difference in the number of workers per household. Table 5 shows that households with one or two retired adults are more likely to have a pre-1981 vehicle. Of particular note, a household with one retired adult and no children is more likely to have a pre-1981 vehicle than any of the single non-retired adult households, with or without children. As one might expect, households of two or more adults with the youngest child of driving age (16-21) are the most likely to have a pre-1981 vehicle.

Table 5: Percent of Households with pre-1981 Vehicles, by Family Lifecycle

Family Lifecycle		
Number of Adults	*Age of youngest child*	*% with pre-1981 vehicle*
2 or more	**16-21**	26.7%
2 or more, retired	**None**	20.5
2 or more	**None**	19.3
One, retired	**None**	19.2
2 or more	**0–15**	19.2
All Households		*18.5*
One	**0-15**	14.8
One	**16-21**	13.2
One	**None**	12.8

Cluster Analysis

The use of means, medians, and other descriptive data tends to hide some of the information in the data. Households with older vehicles are not all the same. Therefore, a cluster analysis[7] was performed to attempt to categorize the households with pre-1981 vehicles based upon six

[6] Mean and median incomes were calculated using the midpoints for the income ranges of the HHFAMINC variable.

[7] K-means simple cluster method

variables: the number of drivers, the number of vehicles, whether the adults were retired (from family lifecycle variable), whether the youngest child was a teen of driving age (from family lifecycle variable), the number of workers, and the household income (standardized using z-scores). Five distinct clusters emerged and are described in Table 6 using the variables from the cluster formation.

Table 7 provides additional descriptive data on the clusters. Differences in driving patterns between the clusters are described later in this paper. Most of these households have a high ratio of vehicles to drivers, ranging from 1.10 for the large households with teens to 2.71 for the car collectors. The mean ratio of vehicles to drivers for all households with vehicles of all vintages is 1.08. Therefore, except for Cluster 2 (large households with teens), these households have above average vehicle ownership rates.

Table 6: Clusters of Households with pre-1981 Vehicles

Cluster #	*Label*	*Mean # drivers*	*Mean # vehicles*	*Mean # workers*	*% retired*	*% with teens*	*Mean Income*	*% of hhlds*
1	2-adults	**2.12**	2.73	1.77	7.2%	14.9%	$39,510	40.5%
2	Teens, large hhld	3.41	3.70	3.10	1.6	**71.0**	44,525	10.6
3	Car collectors	2.43	**5.86**	1.70	10.6	26.3	51,995	3.9
4	High income	2.52	3.49	1.96	3.8	23.2	**175,000**	2.2
5	Retired or single	**1.40**	1.65	.56	**38.2**	6.2	21,535	42.8

Table 7: Additional Cluster Characteristics

Cluster #	*Label*	*Vehicles per driver*	*Persons per hhld*	*Adults per hhld*	*% in urban area*
1	2-adults	1.34	3.11	2.14	49.5%
2	Teens, large hhld	1.10	4.23	3.17	58.5
3	Car collectors	2.71	3.17	2.40	42.5
4	High income	1.42	3.23	2.38	58.4
5	Retired or single	1.25	2.12	1.59	57.3

Who Drives Older Vehicles?

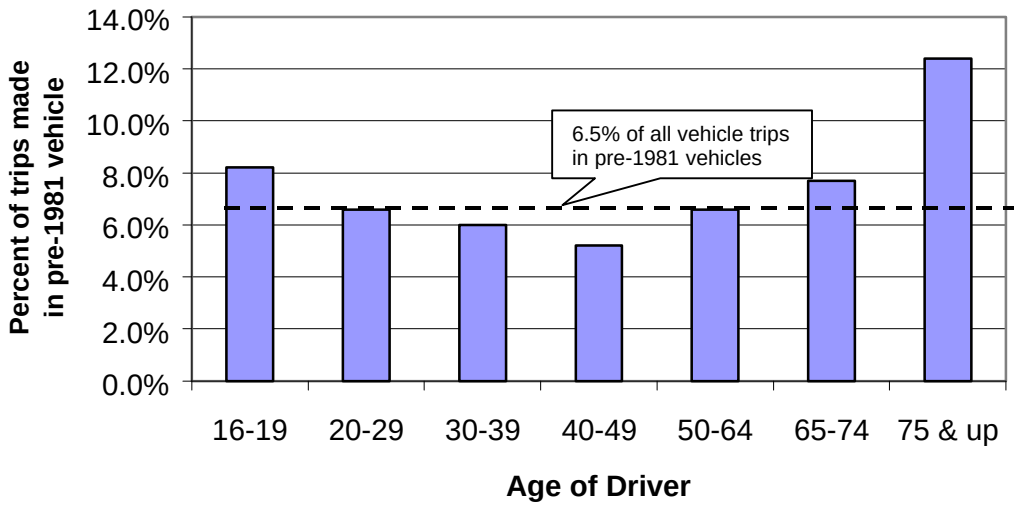
The discussion up to this point has focused on which types of households have older vehicles and where the older vehicles reside. The next logical question to ask is, within these households, who drives the older vehicles? The NPTS asks whether a single household member is the main driver of each vehicle and, if so, who. Overall, 91.2% of the vehicles had a main driver, but only 85.4% of the pre-1981 vehicles had a main driver. This indicates that many of the older vehicles may be "extra" vehicles shared among the household.

There is a significant gender difference in main drivers. While men and women were split fairly evenly as main drivers for 1981 and newer vehicles (48.9% men and 51.1% women), men were far more likely to be the main driver of a pre-1981 vehicle (74.0% versus 26.0%). One possible reason is that in families with children and a male and female adult, the female may use the

newer car to transport children. Another factor may be that a portion of the pre-1981 vehicles are considered "collector" cars, traditionally a male-oriented hobby.

Looking at vehicle trips made in household vehicles recorded on the NPTS travel days, teens and the elderly are more likely to drive pre-1981 vehicles. This is consistent with the lifecycle data for the households. Figure 5 shows that 6.5% of all household vehicle trips were made in pre-1981 vehicles. For trips made by teen drivers (16-19 years old), 8.2% were in the older vehicles. For trips made by drivers over 75 years old, 12.4% of were in pre-1981 vehicles.

Figure 5: Percent of Personal Vehicle Trips made in pre-1981 vehicle, by age of driver



How are Older Vehicles Used?

Overall Use

Based upon the 1995 NPTS data for vehicles with known vintage, pre-1981 vehicles comprise 11.7% of the household fleet, make 6.5% of the household vehicle trips, and represent 4.7% of the annual household VMT (based upon odometer readings, see below).

VMT

Self-reporting vs. Odometer Readings

The NPTS survey asked respondents how many miles each vehicle was driven during the last 12 months or, if the vehicle was acquired less than 12 months previously, since the vehicle was bought/received. In addition, for about half of the vehicles, odometer readings were taken and successfully converted into annualized mileage figures. Table 8 shows the mean annual mileage figures using both methods for older and newer vehicles. The table includes all vehicles for which VMT data was available for either method. It indicates that owners may underestimate annual mileage for 1970s vehicles, while overestimating the use of pre-1970 and 1981 and newer

vehicles. However, this difference may be a factor of which vehicles had valid odometer readings. There were 1,489 1970s vehicles with both odometer readings and self-reported mileage figures. For these vehicles, owners overestimated use by 11% (Table 9).

Table 8: Annual VMT by Vehicle Vintage (all vehicles with data)

Mean	*Pre-1970*	*1970-80*	*>= 1981*
Annual VMT (odometer)	3,175 *n=308*	7,263 *n=1,721*	12,230 *n=29,590*
Annual VMT (self-reported)	3,654 *n=1,029*	6,983 *n=4,787*	12,981 *n=58,395*
Percent difference	+ 15%	- 4%	+ 6%

Note: Means are based upon weighted data; n reflects unweighted data.

Table 9: Annual VMT by Vehicle Vintage (vehicles with self reported and odometer data)

Mean	*Pre-1970*	*1970-80*	*>= 1981*
Annual VMT (odometer)	2,561 *n=285*	5,364 *n=1,489*	11,876 *n=26,794*
Annual VMT (self-reported)	3,292 *n=285*	5,935 *n=1,489*	12,385 *n=26,794*
Percent difference	+ 28%	+ 11%	+ 4%

Note: Means are based upon weighted data; n reflects unweighted data.

Operators of VAVR programs often survey participants and ask them about annual VMT. However, to estimate emissions benefits CARB recommends using fleet averages by model year from smog check odometer readings. Like NPTS survey respondents, participants in VAVR programs may overestimate mileage. This was demonstrated in Unocal's second SCRAP program where smog check odometer readings for 70% of the vehicles were compared to survey responses. However, the odometer readings for the scrapped vehicles were 12-26% lower than the fleet averages for those model years (Unocal Corportation 1994). Evidence from a VAVR program in the San Francisco Bay Area also indicates that vehicles that are scrapped voluntarily are driven fewer miles (according to the owners) than fleet averages by model year (Dill 1999). This indicates that vehicles currently attracted to VAVR programs are used less than average for their model year.

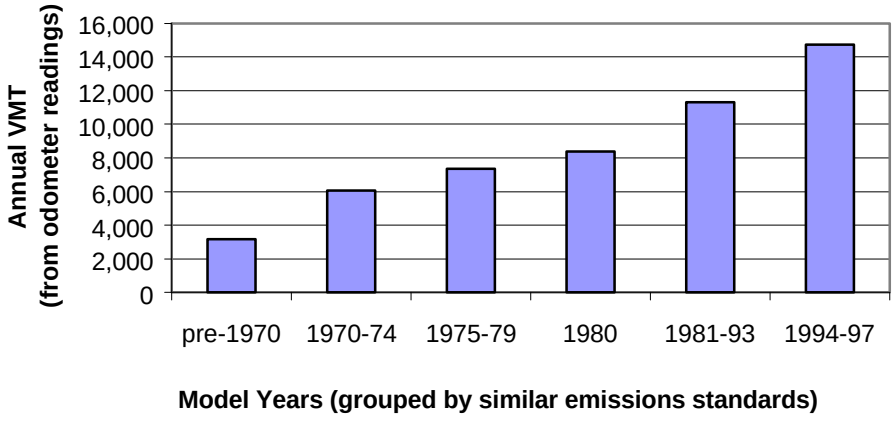
For the purposes of this paper, both self-reported and odometer-based VMT will be used. In some cases, there are not enough odometer readings to perform some analyses and self-reported figures are used. Successful odometer readings were conducted on about 30% of the pre-1981 vehicles.

VMT and Household Characteristics

Annual VMT declines with vehicle age (Figure 6). A small portion of the pre-1981 vehicles are not driven; 2.4% of the valid odometer readings registered zero miles and 2.7% of the pre-1981

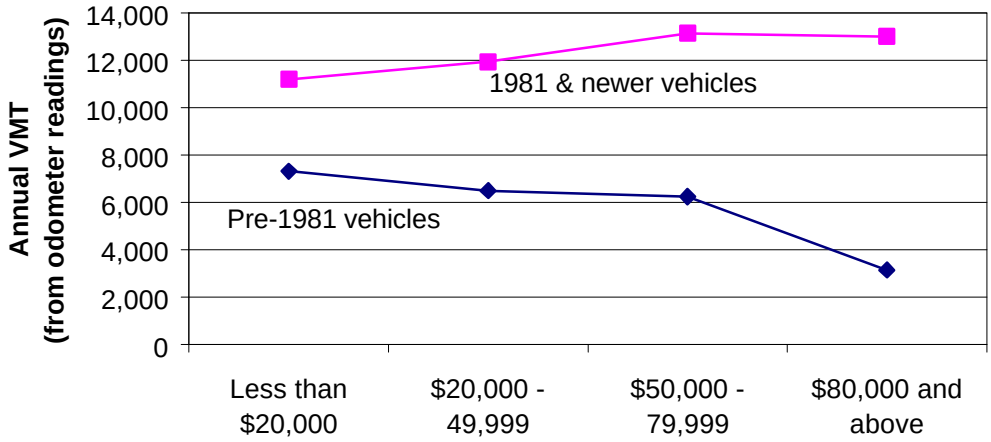
vehicle owners indicated zero mileage. This compares to 0.2% and 0.3% of the newer vehicles based upon odometer readings or self-reporting, respectively. Pre-1970 vehicles were even more likely not to be driven, 4.1% and 6.2%, respectively.

Figure 6: Annual VMT by Model Years (from odometer readings)



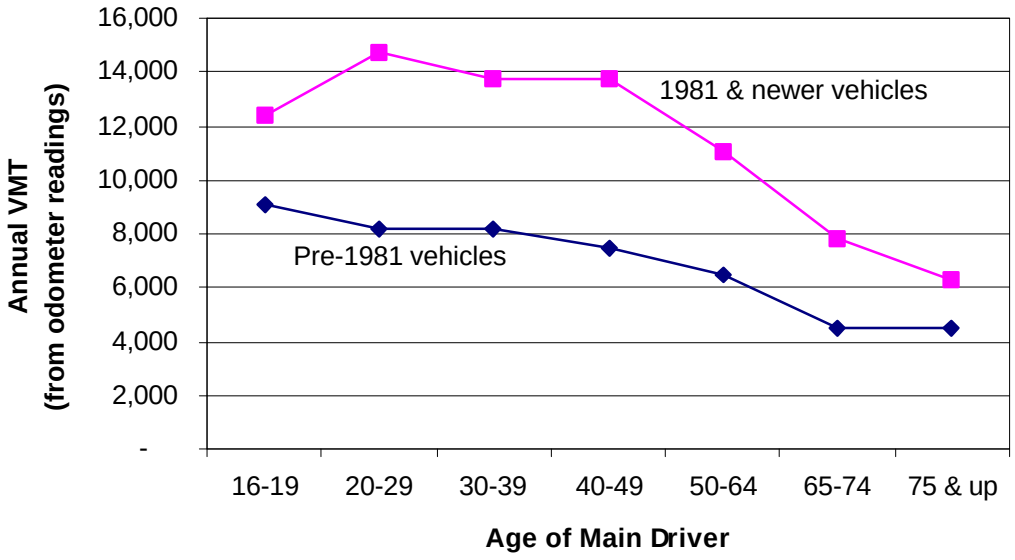
Patterns of use are not consistent between households. For 1981 and newer vehicles, annual VMT increases as income increases, while pre-1981 vehicles are driven less as income increases (Figure 7). This is consistent with earlier findings that for lower income households, the older vehicle is more likely to be the only vehicle.

Figure 7: Annual VMT by Income and Vehicle Vintage



Differences in VMT between pre-1981 and newer vehicles also vary by the age of the vehicle's main driver (Figure 8). For teen drivers, VMT for newer vehicles is about 36% higher than for pre-1981 vehicles. In contrast, the newer vehicles are driven 68-84% further than pre-1981 vehicles whose main drivers are 20-74 years old. For the oldest drivers, the difference in VMT is about 40%. This indicates that for teens and the elderly the older vehicle is more likely to be a the only vehicle available.

Figure 8: Annual VMT by Age of Main Driver and Vehicle Vintage



Trips

Trip Length and Purpose

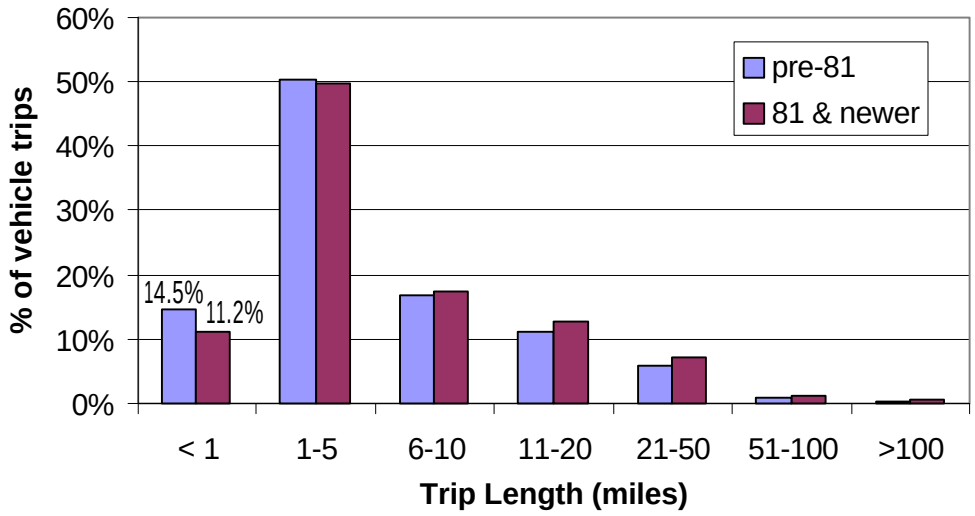
Trips made in pre-1981 vehicles are about 15% shorter in distance, but only about 4% shorter in time (Table 10). This may indicate that older vehicles are less likely to be driven on freeways, which would be consistent with the high use among older drivers. In addition, despite the fact that larger households are more likely to have older vehicles, there are fewer people in the older vehicles when they are used. This may be consistent with an earlier theory that in families with children the older cars are less likely to be used to transport children.

Table 10: Trip Characteristics

Mean	*Pre-1981*	*1981 & newer*	*Diff.*
Distance (miles)	7.56	8.87	-15%
Travel time (min.)	14.9	15.6	-4%
# persons on trip	1.50	1.59	-6%

Average trip distances are shorter for older vehicles in part because a higher portion of the trips are less than one mile long (Figure 9). Because starting an engine produces a burst of emissions, regardless of the trip length, shorter trips can have a greater impact on air pollution. In addition, emissions occur at the end of a trip due to fuel evaporation from the hot engine. Therefore, ten one mile trips will produce more emissions than one ten mile trip. Vehicles that are started with a cold engine (particularly vehicles with catalytic converters), are of particular concern.

Figure 9: Trip Length and Vehicle Vintage



Older vehicles are more likely to be used for certain trip purposes, such as visiting friends and relatives and medical/dental appointments (Table 11). The vehicles are least likely to be used for vacation and trips to religious activities. These differences in trip purposes are probably due to (1) the characteristics of the households that have older vehicles (e.g. older persons may be more likely to take trips to the doctor or dentist and they are more likely to have an older vehicle) and (2) households making trade-offs between multiple vehicles (e.g. households are unlikely to use an older, less reliable vehicle for a longer vacation trip if a newer vehicle is available).

Table 11: Percent of Trips made by pre-1981 Vehicles by Trip Purpose

Trip Purpose	*% of trips made by pre-1981 vehicle*
Visit friends/relatives	7.4%
Medical/dental	7.3
Other	7.1
Other family or personal business	7.1
Home	6.7
School	6.7
To work	6.6
Shopping	6.6
All Trips	*6.5%*
Take someone somewhere	6.0
Work-related business	5.7
Other social/recreational	5.7
Return to work	5.6
Pick up someone	5.6
Went out to eat	5.4
Vacation	4.4
Religious activity	3.9

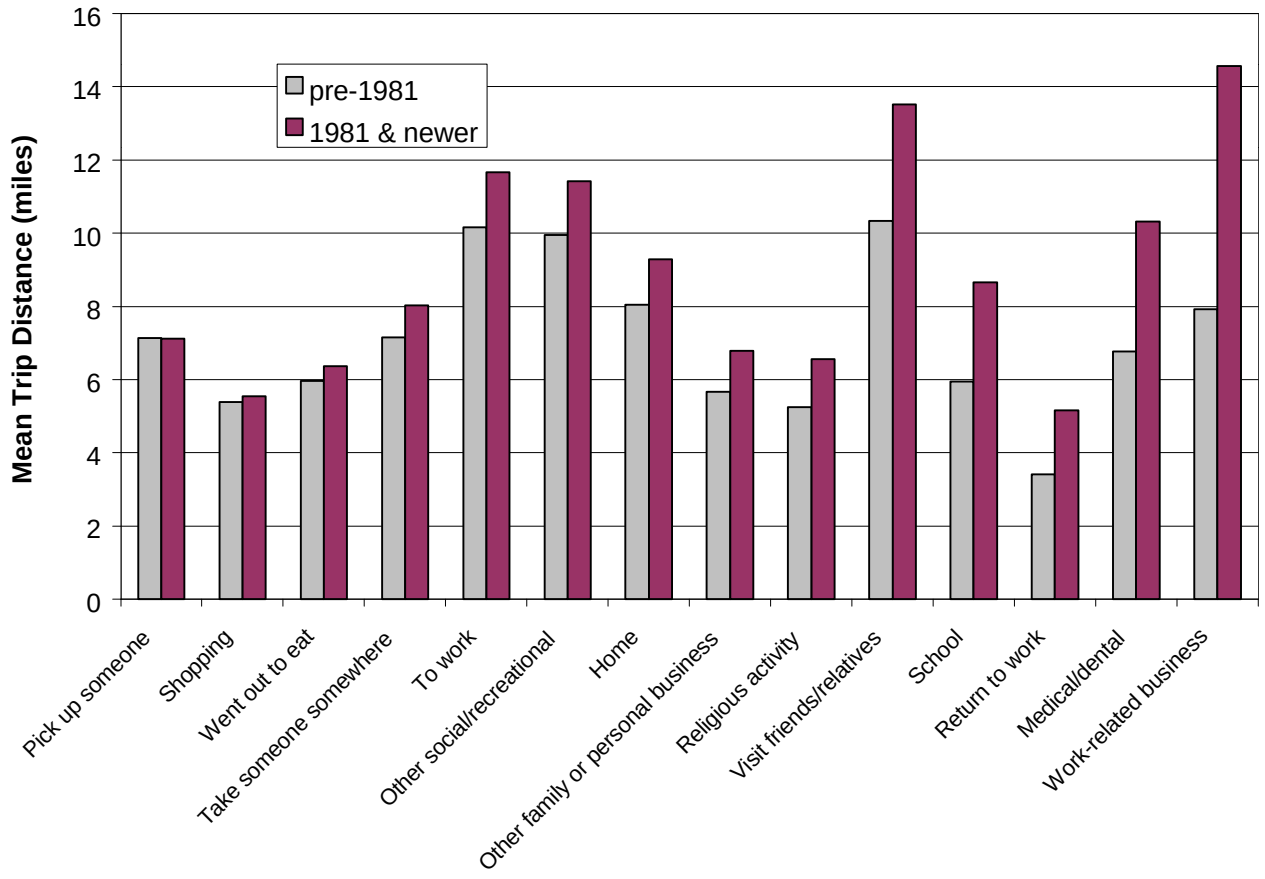
The use of older vehicles for particular trip purposes varies by income. For example, 15.0% of all household vehicle trips made by households with incomes under $20,000 are in pre-1981 vehicles. However, 20.4% of the work-related business trips for these household vehicle trips are made in pre-1981 vehicles. On the other hand, only 13.6% of the trips to work in this category are in pre-1981 vehicles. This may reflect the use of older pickup trucks and vans by low-income, self-employed workers. Of the vehicle trips made by households with incomes of $20,000-49,999, 6.7% are in pre-1981 vehicles. The highest incidence of older vehicle use in this income category is for school trips – 8.5% of those trips were in pre-1981 vehicles.

Trip distances vary by purpose and differences also vary between older and newer vehicles. The mean trip lengths by purpose are arranged in Figure 10 from smallest to largest percentage difference from left to right.[8] For example, when pre-1981 vehicles are used to pick up someone or go shopping they travel about the same distance as newer vehicles. At the other end, work-related business trips made in pre-1981 vehicles are almost half the length of the same types of trips made in newer vehicles. These differences may reflect households making tradeoffs between vehicles based upon trip purpose. For example, household members with longer commutes to school or work might use the newer vehicle. The differences might also be a factor of household or driver characteristics. For example, shorter school trips in pre-1981 vehicles

[8] Vacation and Other trips are not included due to the low number of trips made in older vehicles, making the mean distance unreliable.

might reflect their use by high school students living closer to school rather than college students living further from campus. If lower income households live closer to work and are more likely to use older vehicles, this would reduce work trip distances for older vehicles.

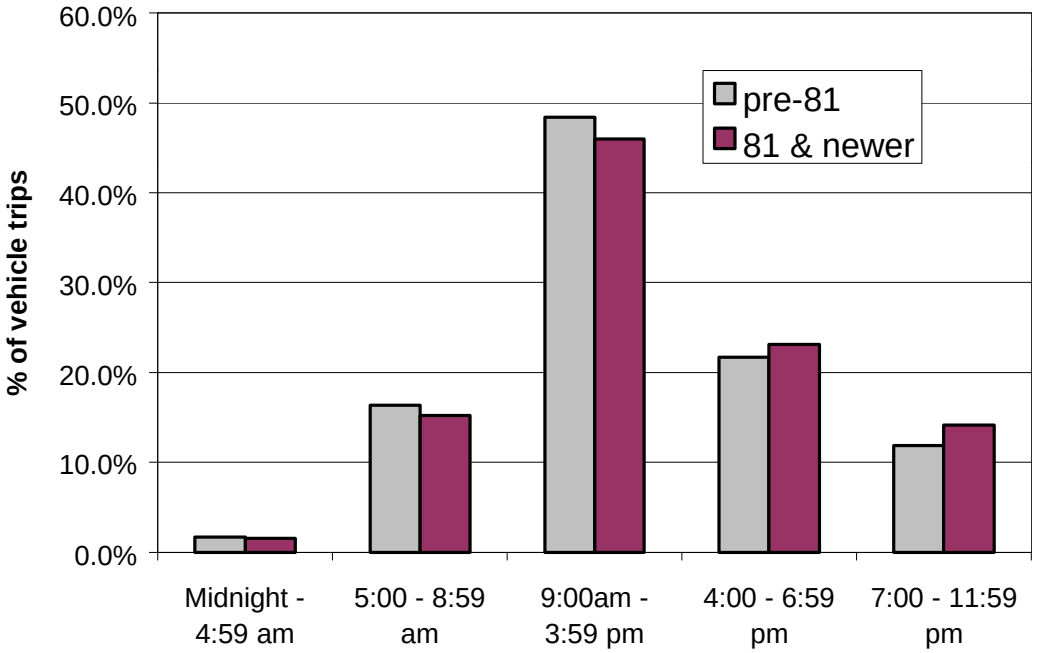
Figure 10: Mean Trip Distance by Purpose and Vehicle Vintage



Time of Day

Figure 11 shows the distribution of vehicle trips by time of day. The trips made in pre-1981 vehicles are more likely to start earlier in the day and less likely to start after 4 p.m. For ozone formation, emissions occurring earlier in the day are of particular importance – there is more time for pollutants generated early in the day to react with sunlight and form smog.

Figure 11: Distribution of Trips by Time of Day



Cluster Analysis

As with ownership patterns, mean VMT and trip distances may hide some of the detail in the data. Therefore, the clusters developed earlier were used to explain some differences in the use of older vehicles. For each household with a pre-1981 vehicle, total VMT was calculated by summing the self-reported VMT for all household vehicles and 1970s vehicles.[9] Similarly, trips and trip distances for the travel day were summed for each household. Since 1970s vehicles are less likely to be a classic or collector vehicle and, therefore, more likely to be a target for a VAVR program, travel patterns for these vehicles are highlighted.

Table 12 shows that households characterized by having two adults (Cluster 1) and large households, particularly with teens (Cluster 2) drive the most miles in 1970s vehicles.

Households in Cluster 5, characterized by a large share of retired and single adult households, make the most trips in 1970s vehicles, an average of 3.0, but do not travel the furthest per day, averaging 19.3 miles. For these households, 1970s vehicles represent an average of about three-quarters of their household vehicles and over half of their annual VMT. Cluster 2 households travel the furthest per day in 1970s vehicles, averaging 22.0 miles over 2.7 trips. In contrast, Cluster 3 households, labeled “car collectors” because they average nearly six vehicles each, on average make about one trip per day in 1970s vehicles, travelling only 8.7 miles.

[9] Odometer readings were not used because of the high rate of missing data.

Table 12: Vehicle Use by Clusters

	Label	Annual VMT in 1970s vehicles	# of 1970s vehicles	% of annual VMT in 1970s vehicles	% of vehicles of 1970s vintage
1	2-adults	7,340	1.2	32.3%	45.0%
2	Teens, large hhld	7,528	1.3	25.0	36.1
3	Car collectors	6,842	1.8	18.6	30.9
4	High income	5,686	1.1	19.0	33.8
5	Retired or single	6,413	1.2	53.3	74.6

	Label	% of trips in 1970s vehicle	# of travel day trips in 1970s veh.	Travel day miles in 1970s veh.
1	2-adults	29.8%	2.1	16.5
2	Teens, large hhld	25.7	2.7	22.0
3	Car collectors	12.1	1.1	8.7
4	High income	12.7	1.0	16.0
5	Retired or single	64.4	3.0	19.3

Conclusions

This paper identified four major questions that might be answered using the NPTS data:

1. Who are the potential participants in VAVR programs?
2. Who might be impacted by VAVR programs?
3. How much do older vehicles contribute to air pollutant emissions?
4. How effective are VAVR programs?

This section attempts to pull together the data already described to start answering these questions.

Potential Participants in VAVR Programs

While all households with pre-1981 vehicles are potential participants in VAVR programs, some of these households are more or less likely to participate. Examining information about participants in existing VAVR programs could help determine the potential share of pre-1981 vehicle households that might participate. Survey results are available from VAVR programs in the San Francisco Bay Area by the Bay Area Air Quality Management District (BAAQMD) and in the South Coast Air basin (Los Angeles region) by Unocal (Dill 1999; Fairbank Bregman & Maullin 1991; Unocal Corportation 1994).

Table 13 includes vehicle ownership rates for the three programs. Also included is household vehicle data for the two CMSAs from the 1995 NPTS. For the BAAQMD and SCRAP II programs, participants tend to have more vehicles than all households with vehicles in the region. In the Bay Area the difference in average number of vehicles per household is about one.

Table 13: Vehicles per Household – VAVR Program Participants vs. CMSA Households

Number of Vehicles	*BAAQMD Program Participants*	*NPTS SF CMSA Hhlds with Vehicles*	*Unocal SCRAP I*	*Unocal SCRAP II*	*NPTS LA CMSA hhlds with Vehicles*
One	8.0%	38.4%	30%	15.2%	35.3%
Two	33.4	38.0	40	52.2	46.4
Three	33.4	16.6	19	23.0	13.0
Four or more	24.7	7.0	11	9.7	5.4
Mean	2.94	1.95	na	na	1.90
n*	1,244	550	803	487	921

* Data for CMSA from NPTS is weighted.

In all three programs, a high portion of participants were retired: 27% in the Bay Area, 24% for SCRAP I, and 29% for SCRAP II. Nationwide, 20.6% of the households with pre-1981 vehicles had one or more retired adults. For the Los Angeles CMSA households with vehicles, 15.8% were retired, and 17.6% of the San Francisco CMSA households with vehicles were retired.[10] This indicates that retired households are strong candidates for VAVR programs. Cluster 5, which includes a high portion of retired households, represents over 40% of the households with 1970s vehicles. These households had an average of 1.65 vehicles and 1.25 vehicles per driver.

Table 14 and Table 15 show the reported household incomes for participants in all three VAVR programs, along with comparable income data from the CMSA for households with vehicles.[11] In all three cases a higher proportion of participants are from low income households (under $15,000 or $10,000) than the region as a whole. This may be surprising, since the bounties offered are not high enough to purchase most used vehicles. On the other hand, a $500 bounty is at least five percent of the annual income for households earning less than $10,000 per year. The vehicles sold to VAVR programs by the lowest income households may be in very poor condition. In addition, retired households on fixed incomes may fall into these lower income categories. These households may no longer need more than one vehicle and see the VAVR program as an easy way to dispose of their extra vehicle. Also of note is the increase in higher income households participating in SCRAP II compared to SCRAP I. This may indicate that as programs continue, the participants change.

[10] The sample was too small to distinguish between households with and without pre-1981 vehicles.

[11] The income categories from the VAVR surveys do not match the NPTS categories. In addition, the categories for the SCRAP surveys are overlapping. However, for comparison purposes, the data is useful.

Table 14: Household Incomes – Bay Area VAVR Participants

BAAQMD Program Participants		*NPTS Bay Area Hhlds with Vehicles*	
Under $15,000	16.1%	Under $15,000	9.2%
$15,000 - 30,000	25.5	$15,000 – 29,999	18.1
$30,001 - 45,000	22.5	$30,000 – 44,999	20.1
$45,001 - 60,000	16.1	$45,000 – 59,999	21.0
$60,001 - 75,000	9.1	$60,000 – 74,999	10.8
Over $75,000	10.8	$75,000 and above	10.5

Table 15: Household Incomes – Unocal VAVR Participants

Unocal SCRAP	*I*	*II*	*NPTS LA CMSA Hhlds with Vehicles*	
Under $10,000	15%	8.7%	Under $10,000	6.0%
$10,000 – 20,000	23	18.6	$10,000 – 19,999	14.0
$20,000 – 30,000	17	19.5	$20,000 – 29,999	15.8
$30,000 – 40,000	17	16.1	$30,000 – 39,999	15.4
$40,000 – 50,000	11	14.1	$40,000 – 49,999	14.8
Over $50,000	18	22.9	$50,000 and above	33.9

Given that existing program participants include many lower income households, the potential market for VAVR programs is large. Households in Cluster 5 (Retired) have the lowest incomes of the five clusters identified. In addition, households in Cluster 1 (two adults) make up over 40% of the households with 1970s vehicles and have a mean income of $39,510, lower than three of the other clusters. They average 1.34 vehicles per driver. On the other hand, these two clusters make the largest share of their vehicle trips in 1970s vehicles (64.4% for Cluster 5 and 29.8% for Cluster 1) and the largest share of their VMT in 1970s vehicles (53.3% and 32.3%, respectively). This indicates that they are more reliant on their 1970s vehicles than the other clusters.

One policy option is to offer older vehicle owners money to repair vehicles or install equipment to reduce emissions. Such a program is underway in San Diego county. These programs might attract vehicle owners who use their vehicles frequently and are not willing or able to purchase a replacement vehicle. For example, households in Cluster 2 have the lowest ratio of vehicles per driver, indicating that all household vehicles are used. In addition, they had the highest annual VMT for 1970s vehicles. Their household incomes averaged over $44,000; however, these households also averaged over three workers, indicating relatively low income per worker. These households make up just over ten percent of the households with 1970s vehicles.

Impact of VAVR Programs on Households

Older vehicles are more likely to be owned by lower income households (Figure 2). Over one-quarter of the 1970s vehicles are in households with incomes under $20,000 and over 40% are in households with incomes under $30,000. Therefore, non-voluntary programs to discourage the ownership of older vehicles would impact lower income households.

The lower income households are also more likely to acquire their older vehicles used. Therefore, a significant reduction in the supply of inexpensive used cars or parts could impact these households. However, the extent of the impact would depend upon the size of the VAVR program. Moreover, it appears that some lower income households are participating voluntarily in VAVR programs, indicating some level of benefit from the programs.

Emissions from Older Vehicles

Pre-1981 vehicles comprise 11.7% of the household fleet, make 6.5% of the household vehicle trips, and represent 4.7% of the annual household VMT. The fact that the share of trips made in older vehicles is higher than the share of VMT is of concern for air quality. As described earlier, the number of trips, not just the miles of travel, has a large impact on emissions. Therefore, emissions estimates based upon annual VMT that assume similar trip patterns for all ages of vehicles may underestimate the contribution of older vehicles. In addition, older vehicles are driven earlier in the day (Figure 11), which could increase their impact on ozone formation. If they are driven at lower speeds or more stop-and-go driving, as indicated in table 10, this may also increase their emissions of certain pollutants, particularly VOCs and CO.

Effectiveness of VAVR Programs

The effectiveness of a VAVR program will depend in part on which vehicles are scrapped. The travel survey data from the NPTS and similar surveys may of use in estimating how older vehicles would be driven if they were not scrapped. Current estimates are usually based upon fleet averages by model year – data available through smog check or other inspection programs. If scrapped vehicles are not “average,” estimates will be inaccurate. Evidence cited earlier from SCRAP II and the BAAQMD program indicate that scrapped vehicles are driven less than fleet averages. This is not surprising – VAVR programs are not likely to draw randomly from the population of older vehicles. For example, based upon the three programs’ survey data, retired persons are more likely to participate. The cluster of households in the NPTS survey with a high portion of retired persons (Cluster 5) drove fewer total miles in 1970s vehicles than all households with 1970s vehicles (6,413 miles vs. 6,907 miles). The "high income" cluster (cluster 4) is also a potential target for VAVR programs. They averaged 1.42 vehicles per driver, indicating excess vehicles, and only drove the 1970s vehicles an average of one trip per travel day. These households drove their 1970s vehicles an average of 5,686 miles per year, over 1,000 miles less than the average. Therefore, if these vehicles are disporpotionately attracted to VAVR programs, estimates of effectiveness may be overstated.

With limited incentives ($500-750), VAVR programs may not be able to reach lower income households that rely heavily upon their older vehicles. For example, 8.5% of the pre-1981 vehicles are in single-vehicle households with incomes under $20,000. These households are perhaps the least likely to be able to replace their older vehicle with a newer, cleaner vehicle with only the incentive offered from a VAVR program. They might be potential targets for a repair program, instead.

Future Research

The data presented here starts to answer some of the research questions raised, but leaves many remaining. A more detailed analysis of trip making within households with older vehicles would

better explain the role of older vehicles in a households' daily travel needs. Such an analysis could reveal the extent to which the differences between trips made in older and newer vehicles are due to differences in household characteristics or whether households are making tradeoffs between older and newer vehicles. A more detailed analysis might better identify potential participants in VAVR and repair programs. In addition, the travel data could be combined with emissions factors to estimate overall contributions from older vehicles and the potential impact of reducing the number of older vehicles through VAVR programs or installing pollution control equipment through repair programs.

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